DOCUMENT RESUME

ED 428 672 IR 019 333

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TITLE	Using Situated Learning and Multimedia To Promote Higher-Order Thinking.
PUB DATE	1998-06-00
NOTE	10p.; In: ED-MEDIA/ED-TELECOM 98 World Conference on Educational Multimedia and Hypermedia & World Conference on Educational Telecommunications. Proceedings (10th, Freiburg, Germany, June 20-25, 1998); see IR 019 307.
PUB TYPE	Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Classification; Cognitive Processes; *Computer Assisted Instruction; Content Analysis; Cooperative Learning; Courseware; Discourse Analysis; *Discourse Modes; *Discussion; Foreign Countries; Higher Education; Interpersonal Communication; Multimedia Instruction; *Multimedia Materials; Preservice Teacher Education; Preservice Teachers; Problem Solving; Qualitative Research; *Thinking Skills; Verbal Communication
IDENTIFIERS	Authentic Assessment; *Learning Environments; *Situated Learning

ABSTRACT

This paper describes a qualitative study that examined students' use of higher-order thinking as they use an interactive multimedia program based on a situated learning framework. The learning environment incorporated the following characteristics of a situated learning model: an authentic context; multiple perspectives; expert performances; coaching and scaffolding; opportunities for collaboration, reflection and articulation; and authentic assessment. The multimedia program focused on the issue of assessment and presented a number of resources for preservice teachers of mathematics to investigate from a variety of perspectives. As they used the program, the preservice teachers were given a complex and sustained authentic task to investigate. It was hypothesized that the situated learning model would lead to higher-order thinking in its implementation. Four groups of two students were videotaped using the resource over 2 weeks, and their discussion was transcribed for analysis with qualitative analysis software. Analysis showed that the majority of thinking was higher order; social, procedural, and lower-order talk was present in reduced proportions. Six figures present a flow chart of a classification scheme of student talk and graphs of proportions of categories of talk and of higher-order thinking. A table contains a summary chart of classification of student talk. (DLS)

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Using situated learning and multimedia to promote higher-order thinking

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Abstract

This paper describes a qualitative study into students' use of higher-order thinking as they use an interactive multimedia program based on a situated learning framework. The analysis of types of talk used by students as they worked with the program clearly shows that the majority of their thinking was higher order, as defined by [Resnick 1987] and other theorists. Social, procedural and lower-order talk was less evident but present in their talk in reduced proportions. These findings suggest that a multimedia program based on a situated learning approach can provide a learning environment capable of supporting and maintaining substantial levels of higher-order thinking.

Introduction

Many educators and researchers discuss the importance of engaging students in activities which require more than the simple application of rules and procedures. [Collins, Brown and Newman 1989] contend that few educational resources (including interactive multimedia) are devoted to higher-order problem solving activities, and few activities require students to use cognitive and metacognitive strategies and processes. [Collins, et al. 1989] suggest that higher order learning—'cognitive and metacognitive strategies and processes'—can 'best be taught' through methods that employ a situated learning approach (p. 455).

While higher-order thinking might most simply be described as 'all intellectual tasks that call for more than information retrieval' [Baker 1990], [Lewis and Smith 1993] give a more comprehensive definition: 'Higher-order thinking occurs when a person takes new information and information stored in memory and interrelates and/or rearranges and extends this information to achieve a purpose or find possible answers in perplexing situations' (p. 136). Many studies have produced methods and procedures to classify and define higher-order learning. However, as [Newmann 1990] points out, each approach has its own persuasive rationale. He contends that it is not productive to try to choose the best, but more sensible 'to search for a common conception that embraces diverse emphases but which attracts professional consensus' (p. 42).

Situated Learning

To date, there appears to have been scant research into whether higher order thinking is enhanced and promoted by learning environments based on a situated learning framework. The majority of studies that have been conducted to investigate students' use of higher order thinking as they use multimedia packages report little evidence of in mainstream student activity (e.g., [Frampton 1994]. While the proponents of situated learning continue to claim that higher order learning is a consequence of learning within a situated learning environment, very little research has been done to evaluate the impact of situated learning elements on students' thinking, particularly with regard to the use of interactive multimedia programs.

This paper describes a study which investigated students' thinking as they used an interactive multimedia program based on the situated learning approach. The learning environment incorporated nine characteristics

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of a situated learning model, namely: an *authentic context*; complex *authentic activities*; *multiple perspectives*; *expert performances*; *coaching and scaffolding*; opportunities for *collaboration*, *reflection* and *articulation*; and *authentic assessment* [Herrington & Oliver 1995]; [Herrington, Sparrow, Herrington, & Oliver 1997]. The learning environment was designed for preservice teachers of mathematics. The multimedia program focused on the issue of assessment and presented a number of resources for preservice teachers to investigate from a variety of perspectives, such as short video clips of assessment strategies being used in classrooms, and interviews with teachers and students on the strategies; and a variety of text documents, such as a description of each strategy and mathematics experts' views. As they used the program, the preservice teachers were given a complex and sustained authentic task to investigate in the form of two letters: one from a parent complaining to the school about the number of tests her child is required to take, and the other a memo to the new teachers at the school (the preservice teachers) asking them to prepare a new assessment plan for mathematics in the school. It was hypothesised that the situated learning model, used in the design of the program, would lead to substantial levels of higher-order thinking in its implementation. Four groups of two students were videotaped using the resource over two semester weeks, and their discussion was transcribed for analysis with qualitative analysis software.

Framework for analysis

Several frameworks have been developed for analysis of student cognition within learning environments, which served as a useful starting point for the current study (e.g.,[Marland, Patching, & Putt 1992]; [Alexander & Frampton 1994]; [Nastasi & Clements 1992]. These frameworks use the basis of student talk as a means of identifying cognition and thinking with the nature of the talk being used as an indicator of the form of cognition and thinking undertaken by the student. The work of [Henri 1992] was most useful in providing a model for analysis of the data in the study. Henri developed her framework for analysis of student talk in a computer-mediated conferencing environment. Student exchanges during lessons were monitored and analysed using content analysis. Clearly, the categorisation of spoken messages within learning environments is a practised format for analysis of student talk.

In order to classify students' talk as they used the interactive multimedia program on assessment, a table of indicators was prepared based on the characterisation of [Resnick 1987] of higher-order thinking. To simplify the classification for the purpose of the research, several of Resnick's characterisations were combined to enable more distinct categories to be drawn. It was also necessary to draw up similar criteria for the classification of talk which could not be considered higher order—*Social*, *Procedural* and *Lower order*—rather than have a simple category of *Non-higher order thinking*. All student talk was classified according to the scheme which is represented diagrammatically below [Fig. 1]:

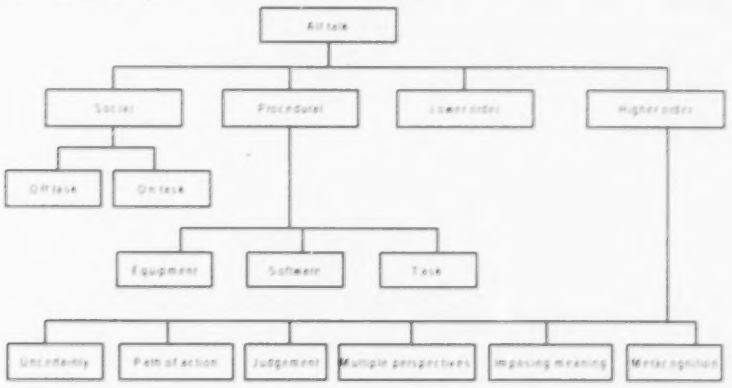

Figure 1: Flow chart of classification scheme of student talk

The unit of analysis

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In order to assign student talk to a category, it was necessary to define the 'grain size' of the unit of speech to be classified. The method used was to count each instance of a type of talk as it occurred [Henri 1992] which enabled the detection of types of talk which may have been neglected by other methods, such as the counting of passages of dialogue, turns at talk, or individual words. Each category of talk, together with a definition, a short summary and example of type is given in [Tab. 1].

Table 1: Summary chart of classification of student talk

Category	Sub-category	Definition	Example of type
Social	Off-task	Any statement not related to the subject matter	G: We got caught in a traffic jam ... We didn't see it happen but we saw a van, the side of it was all smashed in.
	On-task	Any social statements which relate in some way to the task	C: Hey I know this guy ... He was my teacher. What a spin. I wonder what he is doing.
Procedural	Equipment	Any exchange of information related to the equipment (such as the operation of the computer, monitor, keyboard, CD-ROM drive etc.)	R: No you won't have a volume on this ... it'd be on the Apple menu. You have to go into systems folder then control panel.
	Software	Any exchange of information related to the software (any functional aspect of the program itself)	C: That didn't work. R: Did you push copy first?
	Task	Any exchange of information related to the task (the formal requirements of the oral or written report)	G: Are we actually supposed to prepare this as a report to staff? D: No, I don't think so. I think we prepare our notes and then just say it.
Lower order		Any student talk which is routine, requiring little thought, or the mechanical application of well known rules	C: You are missing an r in strategies. R: They are playing dominoes. It is a little primary school class.
Higher order	Uncertainty	Any student talk which involved deciding on an approach to adopt, suggesting a course of action, or any expression of dilemma or uncertainty	L: So really we want to look at all of them don't we? E: OK do you want to start putting anything into our notebooks?
	Path of action	Any talk which involved decisions about which elements of the program to access, what to save in the notebook and negotiations on how to proceed	R: We should go right through the whole lot again. We need to make more notes on it.
	Judgement	Any statement or question which referred to students' attempts to interpret and defend their understanding of the issues presented in the assessment program.	G: If you're going to do anecdotal records ... D: You wouldn't carry them around. You'd make notes and put them in later. G: That's the whole point of having them combined.
	Multiple perspectives	A statement or question was classified in this category if it suggested an alternative approach or challenged a conclusion, or previously made point, by providing an alternative perspective.	R: OK investigations, factual ... Ah, factual, factual recall, rote learning. C: No, it's not saying you learn everything by rote, it's just saying that sometimes you want students to respond automatically...
	Imposing meaning	Talk was classified into this category if it referred to a possible solution to a problem or suggested alternative solution, if it expressed a decision about what to believe, or the creation of a new idea, or if it drew cautious conclusions.	G: Obviously we can introduce all of the strategies but not to start with. I think in the lower primary you probably can't expect them to do a mathematical investigation, so if they start out with oral work in the lower school and work towards doing the written ones in the upper school.
	Metacognition	Any comments which showed that students were aware of their own thinking and performance, and comments related to the use of this awareness to improve performance	G: What was that? I didn't get any of that. E: I don't know what to do. Where is that piece of paper I had before? [The activity]

Discussion

The analysis of the transcripts showed that higher-order thinking was a substantial component in all the students' talk. In each of the four groups observed, the proportion of higher-order thinking to the other major categories observed was quite consistent and was measured at around 70% of the total talk.

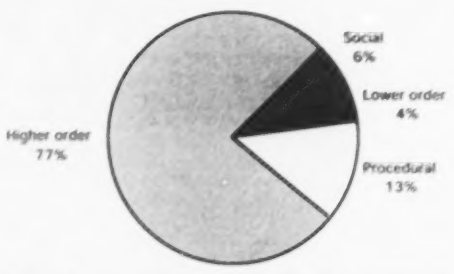

Figure 2: Proportion of categories of talk: Group 1

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[Fig. 2] shows the proportion of categories for Group 1. The two students in this group used a substantial proportion of higher-order thinking in their talk as they used the multimedia program. Lower order comments, together with social talk, were kept to a minimum and procedural matters occupied only a moderate amount of their time. Like Group 1, the students in Group 2 used a substantial proportion of higher-order talk (70%), a moderate amount of procedural and minimal lower order talk. Of all the groups, this group had the most social talk, largely centred around discussion of their mutual friends, computers and work from other units of study. The students in Group 3 were least typical in their pattern of talk. There was a complete absence of social talk which appeared to be the result of the fact that they did not know each other prior to commencing work on the program. The amount of higher-order talk was 71%. A relatively high amount of procedural talk was observed in Group 3 and this was largely related to recurring computer equipment problems which were not satisfactorily rectified until the second week of the study. Like the other groups, however, they had a high proportion of higher-order talk, and minimal use of lower order talk. Group 4 were similar to the other groups in their use of a substantial amount of higher-order talk (68%). The remaining categories of talk were also comparable with other groups.

Proportions of higher-order thinking

The high level of higher-order thinking amongst all the groups meant that there was a substantial number of units of meaning in students' talk which could be classified according to the classification scheme (Table 1). While the amount of talk was quite consistent between the groups, there were many differences in the extent and levels of the various forms of higher-order thinking evident in the talk. The proportion of each of these types to the whole of higher-order talk for Group 1 is shown in [Fig. 3].

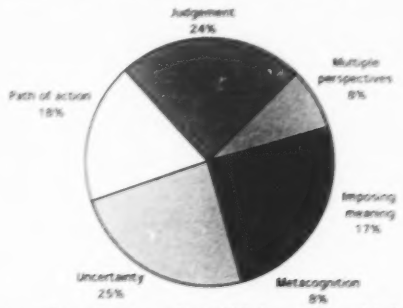

Figure 3: Proportion of categories of higher-order thinking: Group 1

The students in Group 1 used a substantial amount of all types of higher-order talk identified in the classification scheme. As with most of the groups, *Uncertainty*, *Path of action* and *Judgement* comprised the major part of their talk, with the other classifications making up the remainder. Clearly, these students were relatively comfortable working together, with the total of *Uncertainty* and *Path of action* totalling less than half their talk. The moderate proportion of *Multiple perspectives* appeared to indicate that these students were not excessively argumentative or critical, but were not afraid to challenge each other or the program when they saw the need. These students were also capable of spending a good proportion of their time *Imposing meaning* on their learning and coming to conclusions about the task and the recommendations to include in their reports. As with all the groups, these students' expression of metacognitive awareness was minimal, and it is possible that this is a type of thinking which does not manifest in the spoken word as well as the other categories of talk.

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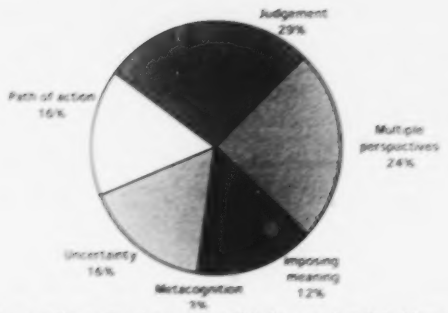

Figure 4: Proportion of categories of higher-order thinking: Group 2

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The interesting aspect of the analysis talk in Group 2 [Fig. 4] is the relatively low proportion of *Uncertainty* and *Path of action* compared to *Judgement* and *Multiple perspectives*. This division indicates that these students were forthright and confident in working out their path through the interactive multimedia program, and that they appeared to very comfortable working together. The high proportion of *Multiple perspectives* indicates that they adopted a very critical approach to the information they were obtaining from the program and from each other. The high proportion of *Imposing meaning* also seems to indicate that they were then readily able to consolidate the information into a meaningful form.

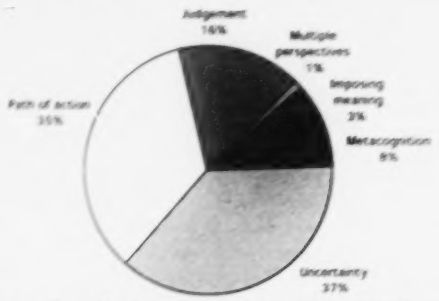

Figure 5: Proportion of categories of higher-order thinking: Group 3

While it is difficult to nominate an optimum spread of talk to categories within higher-order thinking, clearly Group 3 had difficulties which become apparent with closer scrutiny of their types of talk. The high percentage of time spent in both *Path of action* and *Uncertainty* reflects the tentative nature of their collaboration [Fig 5]. Almost three quarters of the total talk fell into one or other of these categories. As they were unaccustomed to working together, the students appeared to spend a relatively large proportion of their time consulting with each other about the nature of their collaboration—how they were to proceed, how to interact, and the responsibility each was to take in the process. Another interesting finding in the proportion of talk for this group was the almost complete absence of *Multiple perspectives* talk between the two students. Their collaboration was characterised by a reluctance to challenge each other's ideas or to challenge the perspectives that were presented in the multimedia program.

The students in Group 4 [Fig 6] used relatively little talk which was classified as *Uncertainty* and *Path of action* indicating that they needed minimal talk to establish a working relationship and a proposed plan of action. Like others, they demonstrated a high proportion of *Multiple perspectives* as they used the program. However, a large proportion of this talk was an argumentative style of interaction they used as they worked together, rather than a thoughtful disagreement with ideas presented in the program. This is possibly evident in the fact that there was a minimal proportion of talk which was classified in the category of *Imposing meaning*. These students, unlike Group 2, did not use the multiple perspectives they offered each other to inform the meaning of the task.

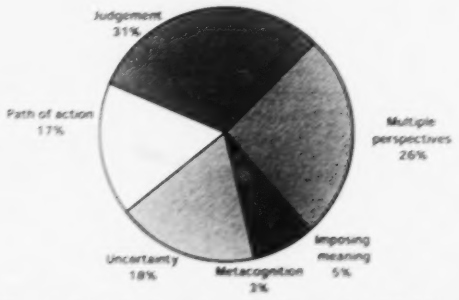

Figure 6: Proportion of categories of higher-order thinking: Group 4

Discussion

It is interesting to note the wide disparity between types of higher-order thinking used by the students as they used the multimedia program. The findings show that all the students used a substantial proportion of higher-order thinking in the situated learning environment, where other studies (e.g. [Frampton 1994]; [Oliver &

McLoughlin 1996] have shown little. The possibility exists that the classification scheme developed to analyse students' talk was not a precise enough instrument to truly reflect the cognition of students as they used the program. For example, comments such as 'What do you want to do now?' may be closer to a cliché or automatic response than a thoughtful reflection of the best course of action. However, even with a reclassification of *Uncertainty* and *Path of action* as *Lower order* thinking, *Higher-order thinking* remains a high proportion of the type of talk used by all the groups. An explanation for the amount of this type of talk is that the constructivist nature of the learning environment provided greater opportunities for students' higher-order thinking.

Another interesting finding was the non-sequential nature of the types of thinking used by the students, confirming the contentions of [Resnick 1987] and [Newmann 1990] that higher-order thinking is relative and non-hierarchical, and counter to behavioural theorists such as [Bloom 1956] and to some extent, [Gagné 1985], where progression to each level of the hierarchy is dependent upon mastery of the previous level. If one accepted a hierarchical approach to classification of thinking, it might be expected that students would begin with a little social talk to establish their working relationship; then procedural talk as they worked out the computer equipment, the software and the task; they might then be expected to move to lower order talk before using higher-order talk later in the session. Interestingly, there was no sequence or pattern to their use of talk. From the beginning, the students moved freely and without notice to any type of talk.

The analysis of types of talk used by students as they worked with the interactive multimedia program clearly shows that the majority of their thinking was higher order, as defined by [Resnick 1987] and other theorists. Social, procedural and lower-order talk was less evident but present in their talk in reduced proportions. These findings confirmed our expectations that a multimedia program based on a situated learning approach could provide a learning environment capable of supporting and maintaining substantial levels of higher-order thinking. Our findings contrast with many previous studies exploring students' cognition and thinking in multimedia use. The findings suggest that the instructional design embraced in the situated learning program and its implementation in this study successfully integrated a number of elements and components often missing in applications and uses of multimedia in contemporary learning settings.

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